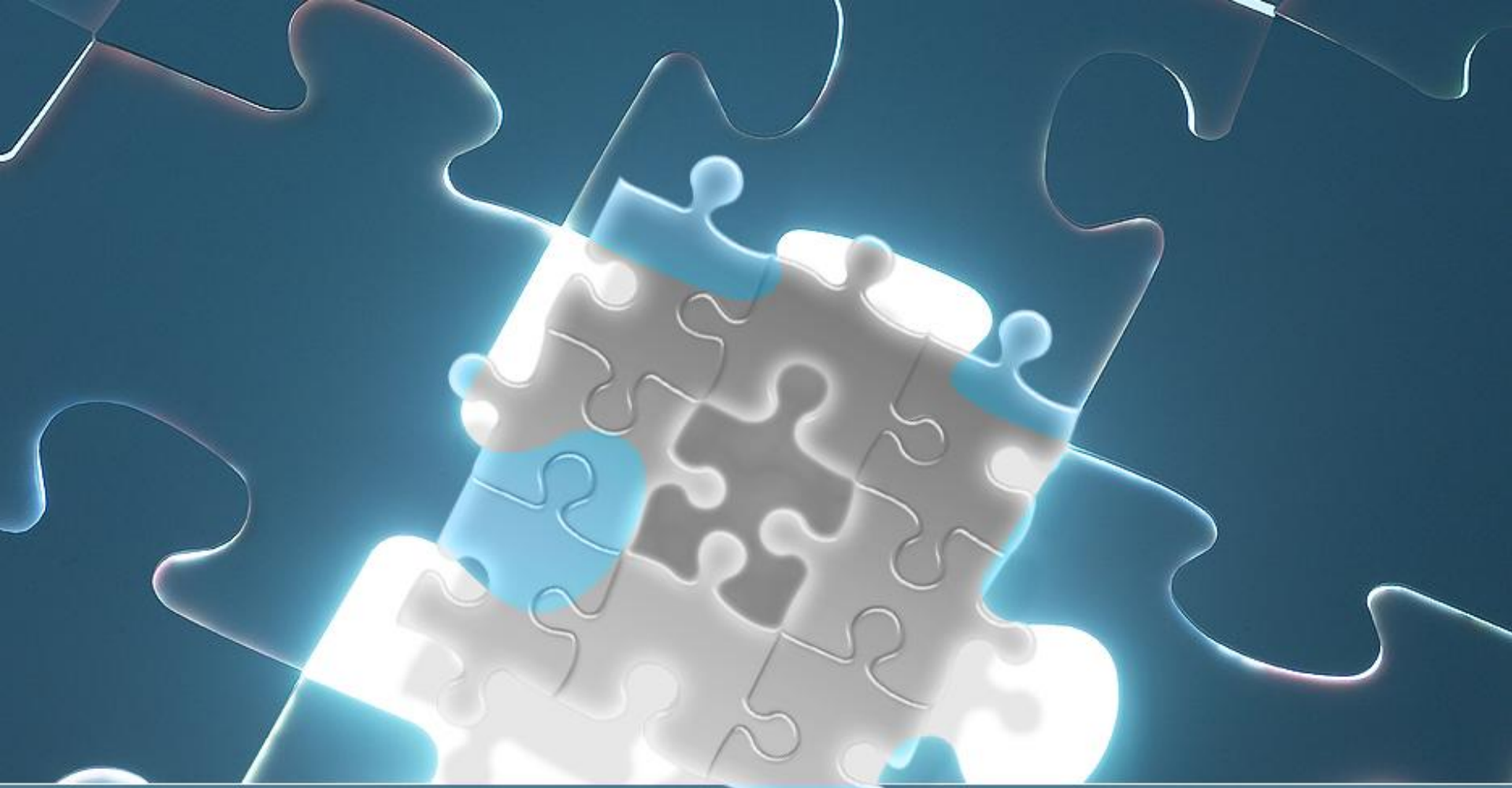


Stream Water Temperature Predictions

Applying HEC5Q modeling to fish production estimates

By: Sharon G Campbell USGS Fort Collins Science Center

What is HEC5Q?

- HEC5Q is a hydrology/water quality model developed by the USACE HEC office in California over 20 years ago.
- The model predicts daily average flow, water temperature, dissolved oxygen, and conductivity values.
- HEC5Q is a one dimensional model, vertical in reservoirs and longitudinally (downstream) in streams.

HEC5Q Limitations

- Does not "handle" February 29th dates
- Does not predict surface water temperature in reservoirs accurately
- Does not capture minimum and maximum daily temperatures – predicts daily average temperature only
- Assumption that the computational units are homogenously mixed from side to side and top to bottom may not be appropriate in all cases

HEC5Q Strengths

- Model is complete for Upper Klamath Lake downstream to the Ocean
- Model has been calibrated to WY1996 and validated for WY 1997 and 1998.
- Model goodness of fit statistics indicate that water temperature is predicted within + or – 1 °C throughout the domain
- POR is 1961-2009 which matches the current SD period of record

Secretarial Determination Details

- Climate change meteorological parameters (air temperature and precipitation) provided by USBR were broadly averaged over large areas and two elevation bands.
- HEC5Q is calibrated and validated to point measurements for these parameters using records from the Montague/Siskiyou and Eureka/Arcata Airports

Secretarial Determination Details

- Climate change air temperatures appeared biased low compared to the past 10 years of measured data for the two locations used by HEC5Q
- After extensive consultation with Lorraine and Alan Flint, USGS SSC, who were providing the tributary climate change stream temperature estimates and Dr. Scott Denning, CSU and the USBR Technical Service Staff, the climate change data were adjusted

Secretarial Determination Details

- The upward temperature adjustment was 1.87 °C for the tributary estimates and 2° C for inland met values and 1°C for coastal met values.
- In addition, there are 3 other required input parameters for HEC5Q temperature predictions were wind speed, cloud cover, and dew point.
- Dew point was derived from average daily air temperature using equations provided by Alan Flint, USGS.

Secretarial Determination Details

- Wind speed and visibility were averaged by day for Montague/Siskiyou and Arcata/Eureka locations and repeated for each climate change met record used to generate stream temperature predictions.
- Again, air temperature and precipitation were supplied by USBR for the climate change scenarios, dew point was calculated and wind speed and visibility were a day average value from historical records

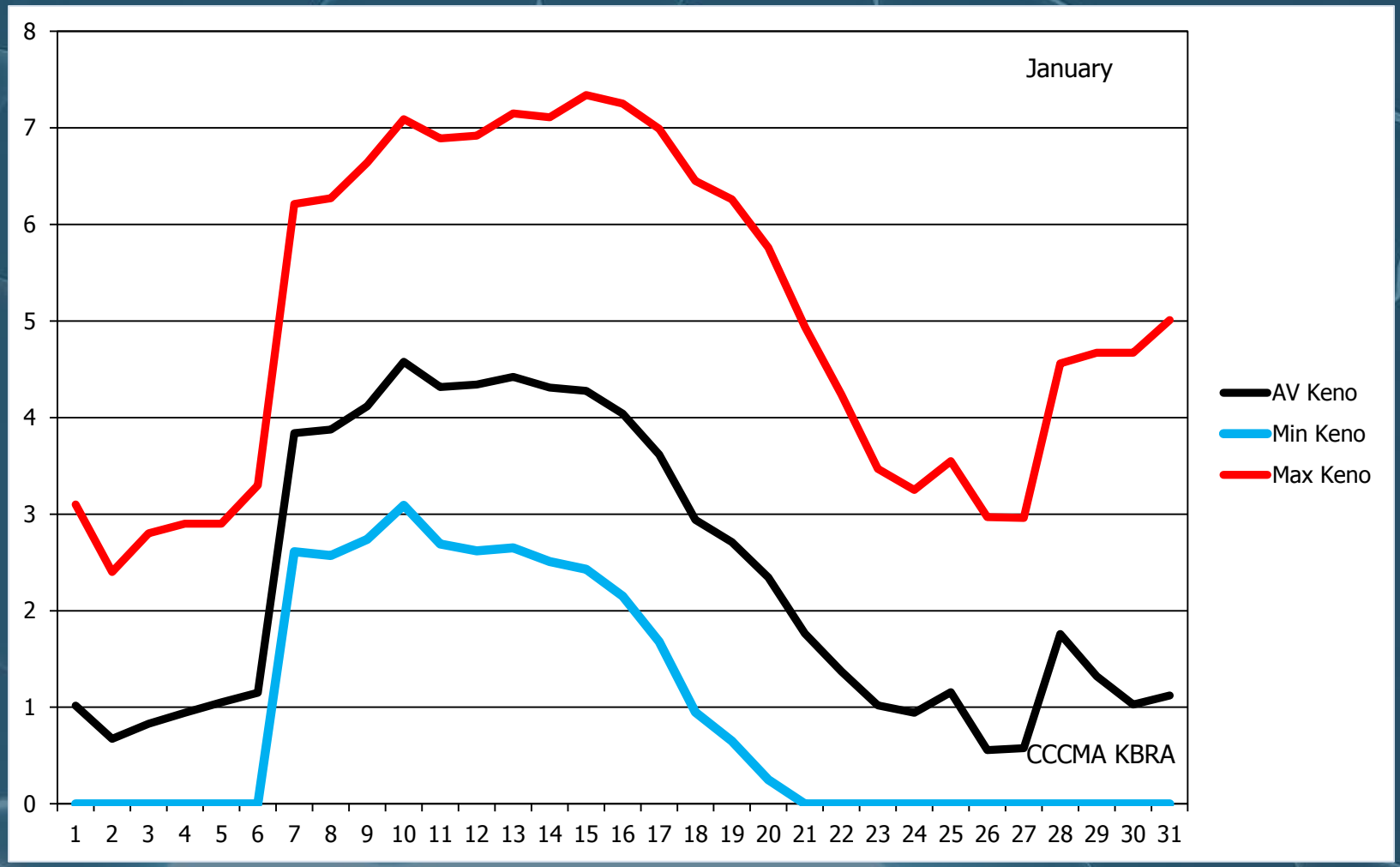
Secretarial Determination Details

- Review of initial HEC5Q simulations and resulting water temperature predictions revealed some departures from expected output values.
- Predicted temperature at the beginning of a month could be substantially different than the last day of the previous month.
- Quarterly boundaries were sometimes very different, i.e. December 31/January 1

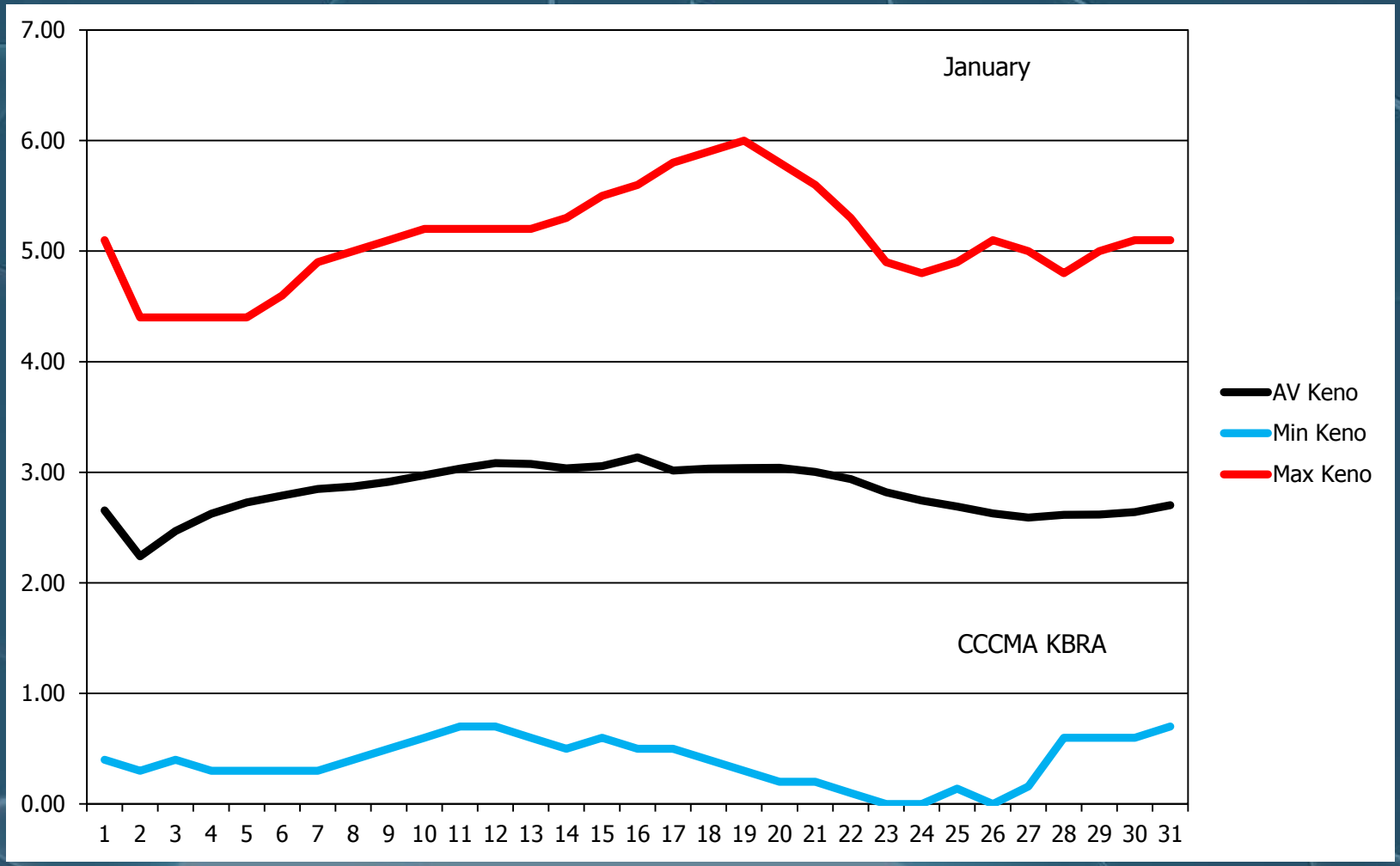
Secretarial Determination Details

- The decision was made to accept these known flaws and move forward because they appear to be embedded in the downscaling and bias correction of climate change model output
- A systematic error in HEC5Q output was also identified. Every January 7-22 in all simulation showed a temperature increase of 3-4 °C.

Systematic Temperature Anomaly



Temperature Correction Results



Another temperature anomaly

- HEC5Q and the Flints tributary climate change output data contain below zero values, apparently because of a sine wave function for the regression equations that yield the temperature estimates
- We have a post-processor temperature correction process that converts < 0 °C values to zero, but we felt that this would be better represented by the value 1 °C

Current Status of HEC5Q

- We are ready to run the revised hydrology provided by USBR on 10/7/10.
- Another set of stream temperature predictions will be generated and after USGS QA/QC, will be provided for review
- Our expectation is that, if this is the final hydrology set, this task will be completed by October 29th.

Questions?